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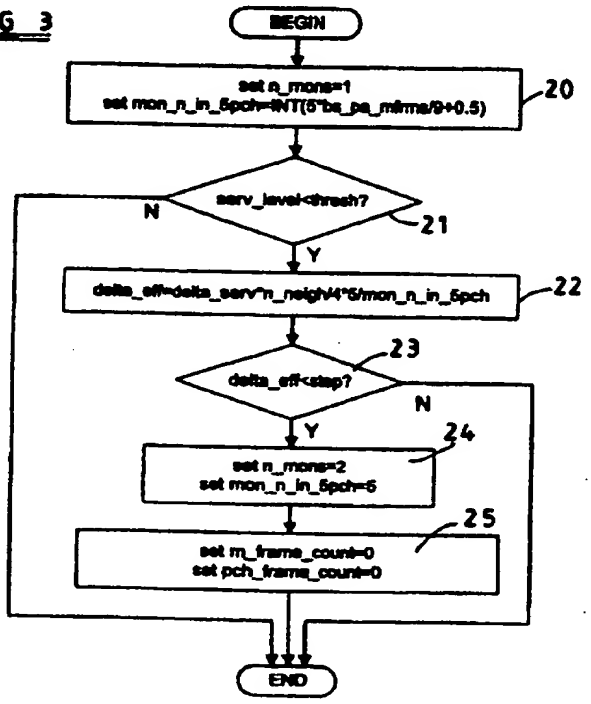
(54) Abstract Title
Base station monitoring control

(57) The rate at which a mobile monitors the received signal strength from neighbouring base stations is controlled in response to the rate of decrease of the current base station signal strength. The monitoring rate is set to its maximum value only when the rate of decrease of the signal received from the current base station exceeds a threshold value or the received signal level falls below a threshold. The monitoring operations may be carried out within selected time slots of a TDMA system frame.

FIG 3



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

2480x3504x2 tiff

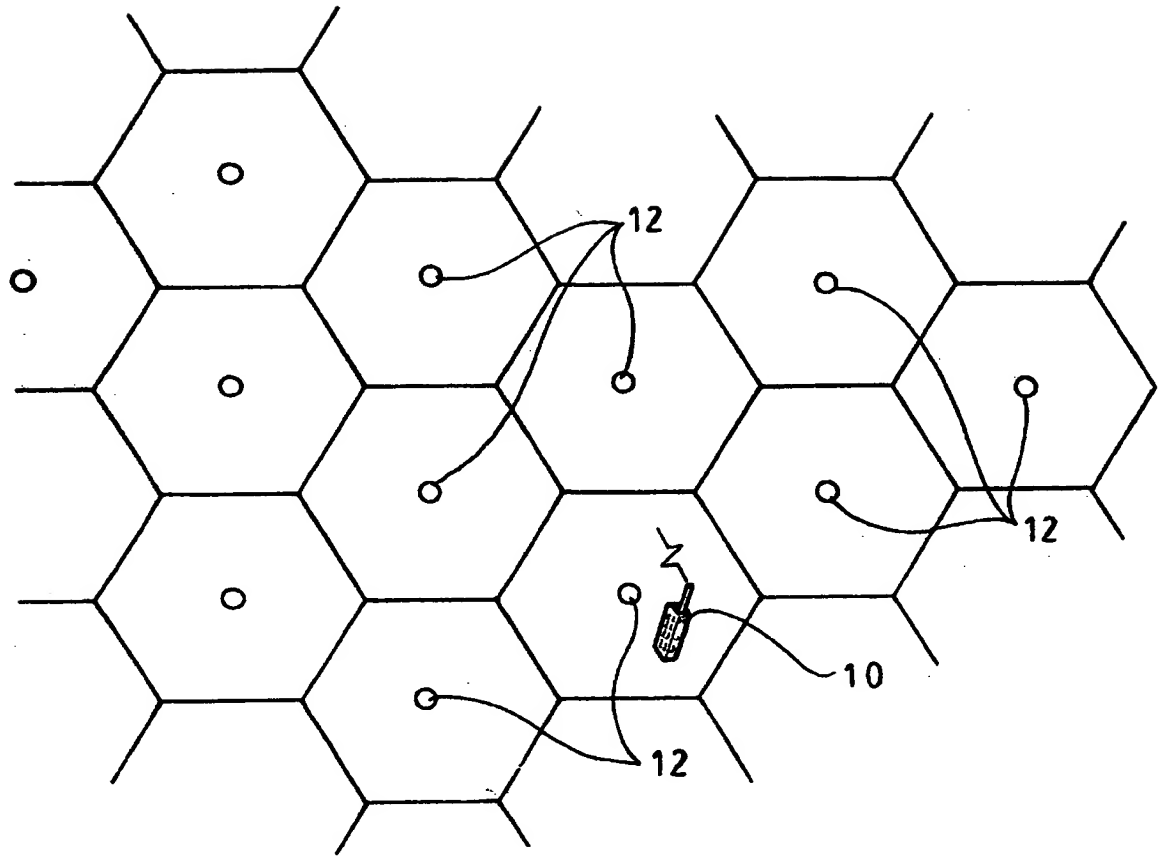


FIG 1

FIG 3

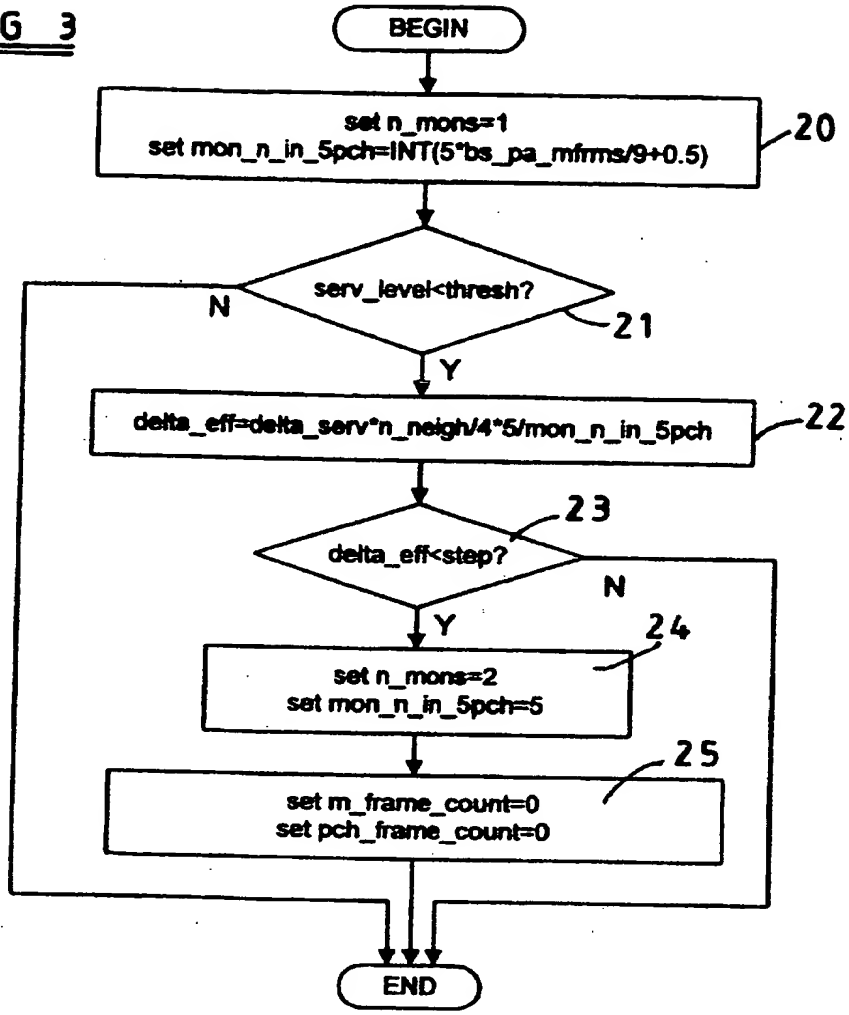
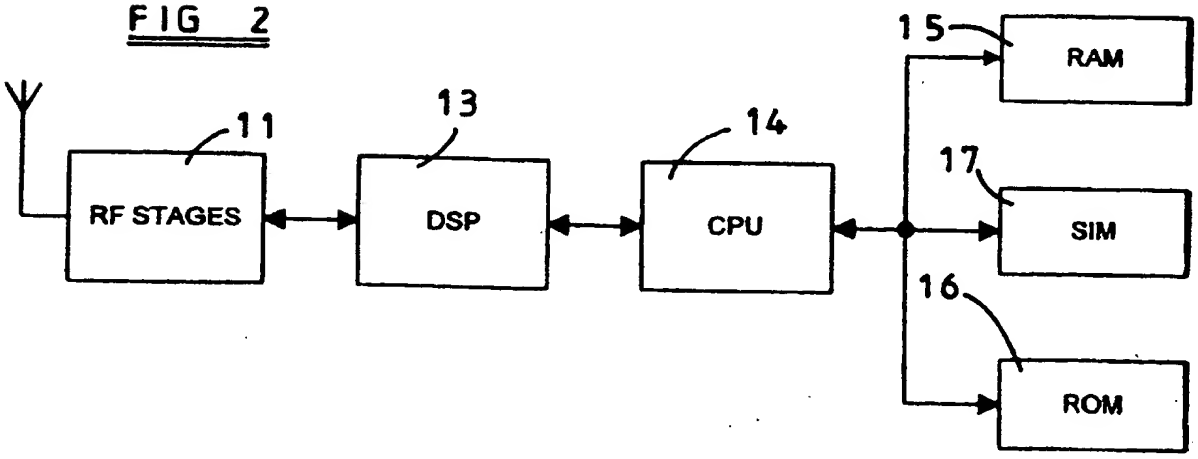

BEGIN
set n_mons=1
set mon_n_in_5pch=INT(5*bs_pa_mfrms/9+0.5)
20
serv_level<thresh?
N
21
Y
delta_eff=delta_serv*n_neigh/4*5/mon_n_in_5pch
22
23
delta_eff<step?
N
Y
24
set n_mons=2
set mon_n_in_5pch=5
25
set m_frame_count=0
set pch_frame_count=0
END

FIG 2


11
RF STAGES
13
DSP
14
CPU
15
RAM
17
SIM
16
ROM

2480x3504x2 tiff

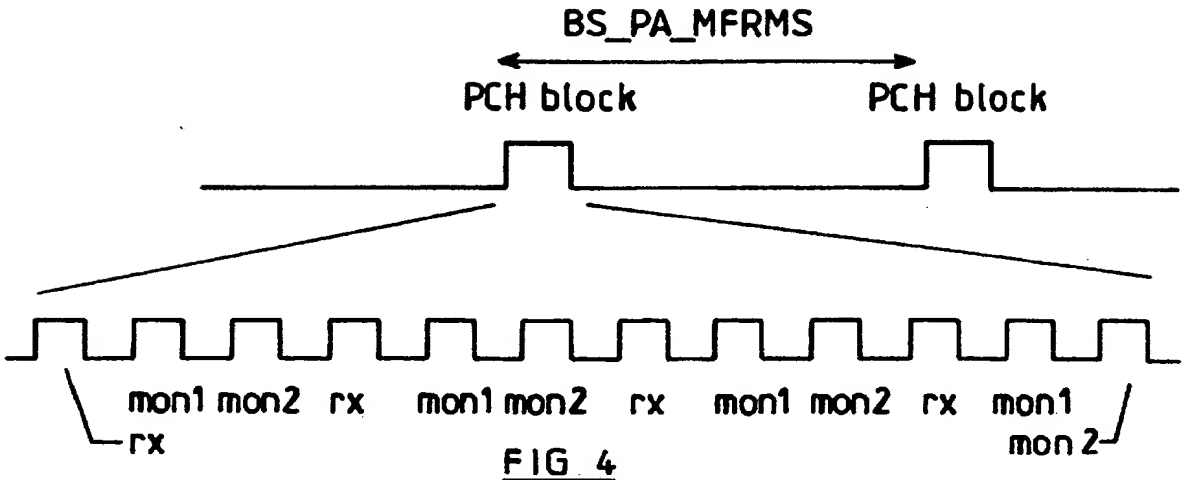


FIG 4

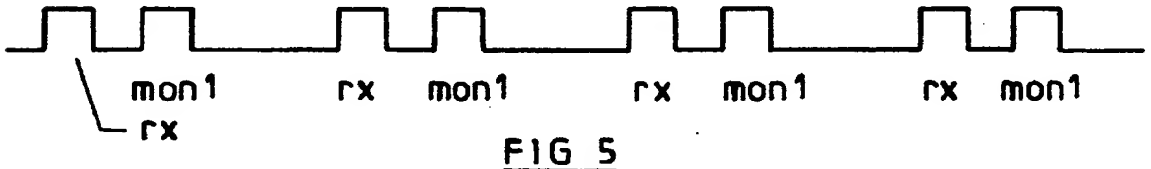


FIG 5

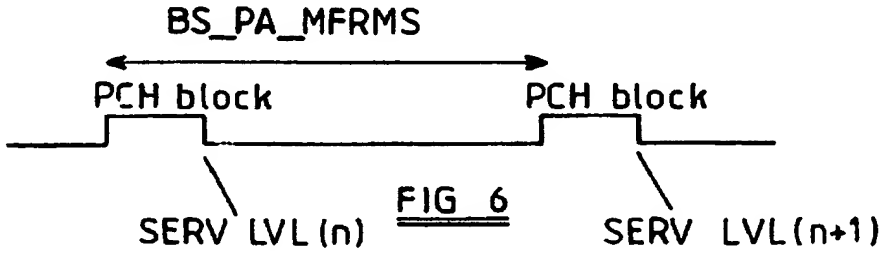


FIG 6

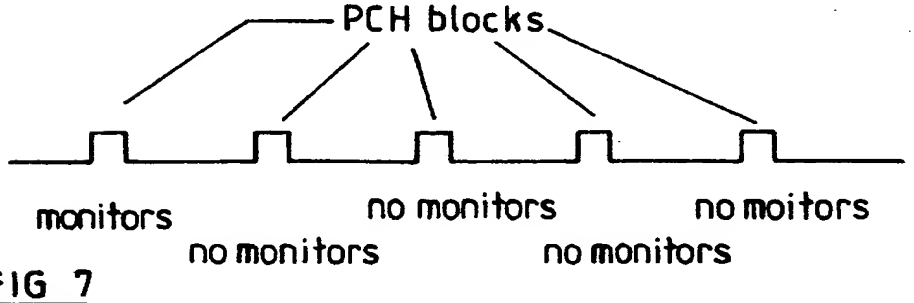


FIG 7

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Mobile Radio Station Base-station Monitoring Control

This invention relates to a base-station monitoring control for use in a mobile radio station such as a GSM mobile phone.

In the GSM system, each base-station reserves four TDMA frame every ***n*** multiframes as a paging channel. The value of ***n*** can be set for a particular base-station to any value from 2 to 9. A single block of paging channel frames are long enough for the mobile station to listen to its current base-station for any incoming call and to receive from two neighbouring base-stations in each frame and measure the signal strength thereof. Thus eight neighbouring stations can be monitored in every ***n*** multi-frame.

If two monitor operations are performed in every paging channel TDMA frame a considerable amount of power will be wasted, if the mobile station is, for example, at the centre of a cell where it is unlikely that any hand-off to a neighbouring base-station will be required imminently. On the other hand, whilst it is simple to arrange that fewer monitor operations are performed, this will have the effect of degrading cell reselection performance.

It is an object of the present invention to provide a mobile radio station for use in a mobile radio network in which the rate at which neighbouring base-stations are monitored can be reduced for power saving purposes without significantly impairing cell reselection performance.

2480x3504x2 tiff

A mobile radio station in accordance with the invention includes means for periodically monitoring the strength of signals received from a current base-station, means for determining the rate of decrease of the current base-station signal strength, means for periodically monitoring the strength of signals received from neighbouring base-stations and operable in a full monitoring mode in which a maximum number of monitoring operations are performed and in a reduced monitoring mode in which fewer monitoring operations are performed, and a monitoring mode selection means for selecting the full monitoring mode only when the rate of decrease of the current base-station signal strength exceeds a predetermined value.

With an arrangement as described above the number of monitoring operations which are carried out can be reduced significantly except when a hand-off becomes imminent as detected by the rate of decrease of the current base station signal strength.

Preferably, means are included for receiving from the current base-station an indication of the frequency of the time slots available for monitoring operations.

The monitoring means is preferably capable of monitoring more than one neighbouring base-station in each available TDMA frame.

Preferably, in said full monitoring mode, the monitoring means operates to perform out a maximum number of monitoring operations in each available TDMA frame, whereas, in the reduced monitoring mode, the monitoring means performs a single monitoring operation in selected ones of the available frames.

2480x3504x2 tiff

Preferably the selection of the number of time-slots in which monitoring operations are performed is determined by said indication of the frequency of available time slots.

In the accompanying drawings:

Figure 1 is a diagram showing a cellular radio-telecommunication network including multiple base-stations;

Figure 2 is a block diagram of the circuitry of a mobile station for use in the network;

Figure 3 is a flow chart of a software routine for determining the rate at which monitoring operations are to be carried out by the mobile station in accordance with an example of the present invention;

Figure 4 is a timing chart showing how multiple monitoring operations are performed within a single PCH TDMA frame;

Figure 5 is a timing chart showing a PCH TDMA frame when only a single monitoring operation is performed;

Figure 6 is a timing chart showing how the PCH TDMA frames are separated; and

Figure 7 is a timing chart showing how monitoring operations are distributed among available PCH TDMA frames when reduced monitoring mode is in operation.

The mobile station 10 includes RF stages 11 which receive data and control signals from base-stations 12 in the network and transmit signal to the base-stations. A digital signal processing unit 13 is included which includes analog to digital conversion means for converting signals received into digital signals which are stored temporarily in the DSP's memory. The DSP 13 is responsible for many of the basic logic operations of the mobile station. A CPU 14 co-operates with the DSP, processing signals passed to it by the DSP 13 and also receiving user instructions from the mobile station's keypad (not shown). The CPU 14 has ROM 15, RAM 16 and also communicates with the SIM module 17 of the mobile station in known manner.

Amongst the functions of the DSP is the monitoring of the strengths of signals from the current base-station and those from neighbouring base-stations. To this end, the CPU maintains a list, known as the BA List, of neighbouring base-stations Ids, and the frequencies on which their control channels are operating. The BA list is maintained on the basis of data transmitted by the current base station. The CPU also maintains a stored value of the last measured signal strength for each base-station in the BA list. The current base-station also provides data identifying the period separating paging channel (PCH) TDMA frames as a number from 2 to 9 representing the period in terms of the number of GSM multiframes which occur in the period. If the number (bs_pa_mfrms) is equal to 2, there will be a PCH frame in alternate multi-frames. If the number is equal to 9, there will be eight multi-frames between the multiframes which include a PCH frame. The base-station also provides data identifying the position of the PCH frame in a multi-frame, but this is not pertinent to the present invention and will not be referred to hereinafter.

2480x3504x2 tiff

Conventionally, when a GSM mobile station is in idle mode (ie no call is connected) the DSP tests the neighbouring base-stations at the rate of two such tests in every PCH frame. In this way, the data about the signal strengths of the neighbouring base-stations is kept as up-to-date as possible, so that, when a hand-off is required, the mobile station already has all the data it needs to select a new base-station from the BA list and commence the hand off.

In the arrangement now described, however, the frequency of testing of neighbouring base-station signal strengths is reduced in normal operation so that power used by such testing is conserved except when a hand-off is judged to be imminently required.

As shown in Figure 3, the CPU carries out a routine following each monitoring operation to determine the required frequency of monitoring operations. At the start of this routine, a variable **n_mons** is set to a value of 1 and a variable **mon_n_in_5pch** is set (20) to a value determined in accordance with the value of the parameter **bs_pa_mfrms** previously referred to. As shown in Figure 3 the value of **mon_n_in_5pch** is set to the integer part of five ninths of **bs_pa_mfrms** plus 0.5. Thus **mon_n_in_5pch** will be 1 if **bs_pa_mfrms** has its minimum value (2), or 5 if **bs_pa_mfrms** has its maximum value (9) and will vary accordingly between these limits. The routine then compares the current base-station signal strength **serv_level** with a threshold value **thresh** (for example -90dbm) and if the signal strength is not less than the threshold, the routine terminates. If the signal strength is less than the threshold, a value **delta_eff** representing the effective decrease in the current base-station signal strength since the previous monitoring operation is calculated (22):

delta_eff = delta_serv * n_neigh/4 *5/mon_n_in_5pch

where **delta_serv** is the actual decrease in the signal strength since the previous monitor, and **n_neigh** is the number of base-stations listed in the BA list .

The calculated value of **delta_eff** is then compared (23) with a value **step** (eg 12 db) which represents the maximum acceptable effective decrease in signal strength between monitors. If this value is not exceeded the routine terminates, but is it is exceeded then the value of **n_mons** is set (24) to 2 (its maximum value) and the value of **mon_n_in_5pch** is set to 5 (its maximum value). Furthermore, the values of a multi-frame count and a pch frame count used by the DSP to determine whether monitors should be carried out in a particular PCH frame are reset.

The CPU uses the variables **n_mons** and **mon_n_in_5pch** to determine how it monitors neighbouring base-station signal strengths. If **n_mons** is set to 2, the DSP will perform two monitoring operations in a PCH frame as shown in Figure 4. If **n_mons** is set to 1, then the DSP will perform a single monitoring operation in a PCH frame as shown in Figure 5. Figure 7 shows the situation where the value of **mon_n_in_5pch** is set to 1. As shown only the first possible PCH slot in each block of five PCH slots is used for monitoring. No monitoring operations are performed in the other 5 PCH blocks. If the value of **mon_n_in_5pch** is 2 then the first two frames will be used for monitoring and so on up to 5.

The CPU maintains separate counts of multi-frames and PCH frames which it resets periodically to enable it to keep the monitoring operations

2480x3504x2 tiff

synchronised. These are the counts which are reset by the CPU when full monitoring mode is commenced.

In an alternative embodiment (not shown) the value of **mon_n_in_5pch** calculated in step 20 is derived from a look-up table.

2480x3504x2 tiff

Claims

1. A mobile radio station in accordance including means for periodically monitoring the strength of signals received from a current base-station, means for determining the rate of decrease of the current base-station signal strength, means for periodically monitoring the strength of signals received from neighbouring base-stations and operable in a full monitoring mode in which a maximum number of monitoring operations are performed and in a reduced monitoring mode in which fewer monitoring operations are performed, and a monitoring mode selection means for selecting the full monitoring mode only when the rate of decrease of the current base-station signal strength exceeds a predetermined value.

2. A mobile radio station as claimed in claim 1 in which there is also provided means for monitoring the strength of signals received from the current base-station and said monitoring mode selection means operates to select full monitoring mode only when the signal strength of the current base-station is below a threshold value.

3. A mobile radio station as claimed in claim 1 or claim 2 in which there is also provided means for receiving from the current base-station an indication of the frequency of time-slots available for monitoring operation.

4. A mobile radio station as claimed in claim 3 in which the monitoring means can monitor more than one neighbouring base-station in a time-slot.

2480x3504x2 tiff

5. A mobile radio station as claimed in claim 4 in which, in said full monitoring mode, the monitoring means operates to perform a maximum number of monitoring operations in each available TDMA frame.

6. A mobile radio station as claimed in claim 5 in which, in reduced monitoring mode, the monitoring means performs a single monitoring operation in a TDMA frame.

7. A mobile radio station as claimed in claim 6 in which, in reduced monitoring mode, the monitoring means performs monitoring operations in selected ones of the available time-slots.

8. A mobile radio station as claimed in claim 7 in which the selection of the number of time-slots in which monitoring is to be performed is determined by said indication of the frequency of time-slots available.

9. A mobile radio station for use in a mobile radio network substantially as hereinbefore described with reference to the accompanying drawings.

2480x3504x2 tiff

The Patent Office

10

Application No: GB 9717741.4 **Examiner:** Glyn Hughes
Claims searched: 1 to 9 **Date of search:** 12 November 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H4L (LECTP, LFM)

Int Cl (Ed.6): H04B 17/00, H04M 1/72, H04Q 7/32, 7/34

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB2305825 A (NEC) see whole document	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.